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The Weather of 1929

Temperature, Sunshine and Wind

By P. I. MULHOLLAND, B.Sc.

The year 1929 will long be remembered for the remarkable variety of its weather and the number of new records created. The abnormal wetness of the last three months and the drought of the preceding months, the severe frosts of the early months and the abnormal warmth of September and the mildness of the latter end of November and most of December, the quiet dry conditions at the beginning of the year and the wet and tempestuous weather at its close provided violent contrasts seldom exhibited in the weather records of this country. The remarkable fluctuations in temperature, however, balanced out on the year and in all districts annual mean temperatures differed only slightly from the normal. Sunshine aggregates, however, exceeded the normal in most districts, the excess being considerable in many parts of England: at Rothamsted 1,854 hours' sunshine were recorded during the year, which is the largest amount recorded since observations commenced at that station in 1852, exceeding by 5 hours the previous record total for the sunny year 1893. Bidston (Liverpool) with an annual total of 1,726 hours and Richmond (Kew Observatory) with an annual total of 1,707 hours had respectively 19 and 16 per cent. more than the normal.

In England and Wales the summer was fine, although the

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lack of rain caused some anxiety to water authorities, farmers and gardeners. In nearly all districts, fine weather was enjoyed on the Public Holidays. Brilliant warm weather prevailed generally on Good Friday (March 29th) and the following day, whilst Easter Sunday and Monday, although cool, were fine, apart from some local showers. Brilliant weather prevailed in all districts on Whit-Monday (May 20th), more than 14 hours' sunshine being recorded in many districts in southern England. The August holiday (August 5th) was fine in the southeast of England with more than 10 hours' sunshine in eastern and southeastern coastal districts and cloudy in other parts of Great Britain with slight rain or showers. The year will be remembered with mixed feelings amongst agriculturists: the intense frosts of the early months, while beneficial to arable land, were fatal to young and susceptible plant life. Although pastures and meadows suffered from the prolonged drought, the brilliant and abundant sunshine greatly benefited cereal crops.

Cold, northerly and easterly winds occurred with considerable frequency in January and February and in both months mean temperatures were below the normal in all districts: January, 1929, was the first really cold January since 1917 and the coldest in London since 1895. The coldness of January, however, was eclipsed by that of February, and in the central and eastern districts of England mean temperatures for the month were from 7°F. to 8°F. below the normal and over the eastern half of England were below freezing point. The cold was most intense during the period 11th to the 17th and the severest experienced generally since February, 1895. The temperature remained continuously below freezing point from the 11th to the 17th over large areas of Great Britain and in some eastern districts from the 11th to the 20th. The temperature in the screen fell to −1°F., at Ross-on-Wye and at Usk (Monmouth) on the 14th and at Houghall (Durham) on the 17th. In contrast to February, March provided many warm days, but low temperatures were frequently recorded at night, the unusually large diurnal range of temperature being a noteworthy feature of the month. During the last few days, the temperature reached an unusually high level, maximum temperatures of 70°F. and over being recorded in several places from the 27th to the 30th and in some places, *e.g.*, at Oxford (72°F. on the 30th) and Meltham, Yorks (71°F. on the 29th), the values recorded were the highest reported in March for half a century. At Wakefield (Yorks) the temperature rose to 77°F. on the 28th, the highest temperature recorded in March in the British Isles since at least 1881. The extreme range in temperature for March was remarkably large in many districts, amounting to as much as 63°F. at Wakefield, 62°F. at Roden, Wellington (Shropshire), and to 60°F. at Mayfield (Stafford). There was a marked prevalence of cold northerly

and easterly winds in April and mean temperatures were below the normal in most places. Monthly mean temperatures were mostly above the normal in May and in several districts in England temperatures in the neighbourhood of 80°F. were recorded about the 23rd. June was mostly cool, although on the 19th the temperature attained or exceeded 80°F. locally in the southeast and east of England.

Although mean temperatures in July and August were generally within a degree Fahrenheit of the normal, there were two notable hot spells; the first was of short duration and occurred about the middle of July whilst the second occurred during the last few days of August and continued until nearly mid-September. During the hot weather in July the temperature rose to 81°F. on the 16th as far north as Strathpeffer (Ross and Cromarty) and to 80°F. on the 15th and 16th at Achnashellach (Ross and Cromarty). In the southeast of England the highest temperatures in July occurred on the 20th, exceeding 85°F. on that date in most places and reaching 89°F. at London (Camden Square) and at Wisley and Newport (Isle of Wight). During the second hot spell 90°F. was recorded in London and at Margate on August 31st and at Newport (Isle of Wight) on September 5th. In London (Camden Square) the temperature rose to 75°F. or over on 5 consecutive days from August 23rd to 27th, and again on 18 consecutive days from August 30th to September 16th. September was abnormally warm and in several places the warmest September for half a century. In the Greenwich records extending back nearly 100 years there was only one hotter September. At Rothamsted September with a mean temperature of 62·0°F. (6·4°F. above the normal) was the warmest month of the year, and by far the warmest September since regular observations commenced there in 1852. Apart from cold weather at the latter end of October, about the middle of November and during the third week of December, the last three months of the year were mild, particularly from November 19th to mid-December.

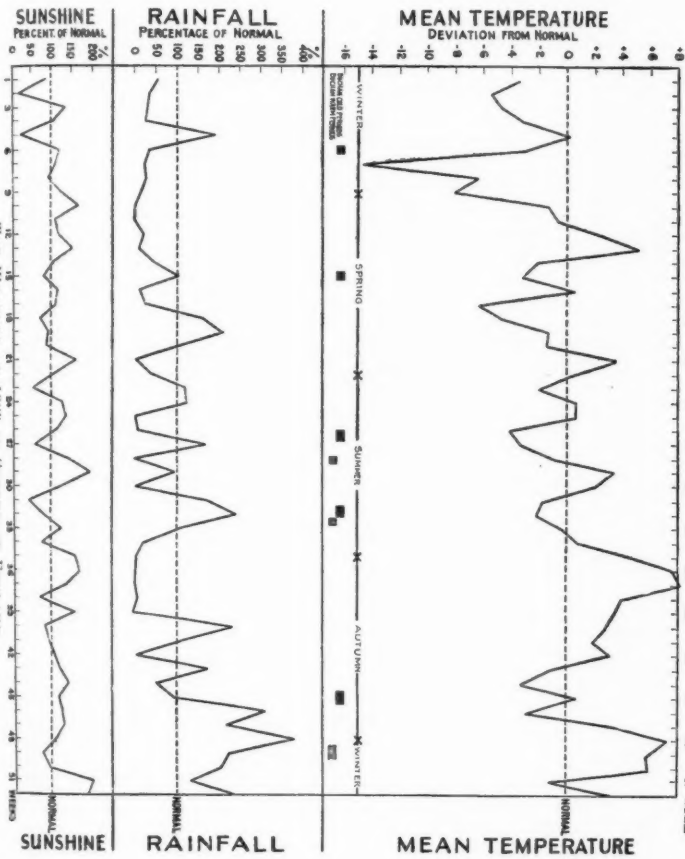
A singularly pleasant feature of 1929 was the excess of sunshine. March and September were conspicuously sunny: the month was the sunniest March for over 20 years at such widely scattered places as Aberdeen, Eastbourne and Teignmouth, for 34 years at Southport and for over 45 years at Strelley (Nottingham) and Cahirciveen (Kerry). Sunshine aggregates were considerably above the normal in September, except in the extreme northwest of Scotland. Daily records of between 11 and 12 hours' bright sunshine were obtained frequently during the first half of the month while during the last week abundant sunshine was recorded in the south and east of England. In the western districts of England and Wales and in the Channel Isles April was the sunniest month of that name since 1921.

There were considerable sunny periods in May in all districts, and in the northwest of England the month was the sunniest May for at least 20 years. There was a considerable excess of sunshine in western districts in June and in some places, *e.g.*, Hoylake, West Kirby, Rhyl, and Pembroke, the total sunshine represented an average of more than 9 hours per day.

In July the only districts with an appreciable deficiency were northern Scotland and southern Ireland. Abundant sunshine was recorded in the southeast of England. The period 12th to the 25th was remarkably sunny and over a large part of England the sunniest fortnight of the year. During this fortnight Rothamsted recorded an average of just under 12 hours. At Hastings (Sussex) the total sunshine recorded during the period July 12th to 17th represented a daily average of 14·5 hours, while at Richmond (Kew Observatory) a daily average of 13·4 hours' sunshine was recorded during the period July 11th to 19th. Except in coastal districts in the south and east of England sunshine aggregates for August were deficient in most places. In spite of the excessive wetness of the last three months of the year sunshine aggregates during this period exceeded the normal in most districts, notably in the central and eastern districts of Great Britain. At Copdock (Suffolk) December was the sunniest month of that name in records extending back to 1901.

Not the least memorable feature of a remarkable year was the storminess of the last three months. Gales occurred frequently in October and November and wind velocities in gusts of 70 m.p.h. and over were widely recorded, notably during the first week of October and on October 23rd and 24th and on November 11th and 24th and 25th. To December, however, belongs the distinction of being the stormiest month of the year. The period December 5th to 12th was unusually stormy, the wind in exposed places in the west and southwest frequently exceeding momentarily 80 m.p.h.; 94 m.p.h. was recorded at Pendennis in the early morning of the 5th. The severest gale of the year was associated with the passage of a vigorous depression on the 6th to 7th, the wind in a gust attaining a velocity of 111 m.p.h. at Scilly on the 6th, the highest on record in Great Britain, and 103 m.p.h. at Pendennis also on the 6th. The gales were responsible for much structural damage, an unusually large number of casualties amongst shipping and loss of life. The storminess of the last month of 1929 was in marked contrast to the quietness of the first month which at Southport, for example, was the calmest January in 58 years.

The diagram reproduced on page 281 shows the variations in weekly district values of temperature, rainfall and sunshine in southeast England during 1929. The district values are expressed as deviations from or percentages of the normal for the period 1881-1915, and are computed as the means of the



THE WEATHER OF 1929 IN SOUTH-EAST ENGLAND.

corresponding deviations and percentages for each of the following stations:—Richmond, Margate, St. Leonards, Southampton and Marlborough. Buchan's cold and warm periods have been added to the diagram, and readers will be able to judge for themselves how far the experience of 1929 supports the suggestion that cold and warm periods occur at more or less well-defined periods of the year. In this connexion the reader is referred to the article, "The First Cold Spell of the Year," which appears on page 285 of this magazine.

Rainfall

By J. GLASSPOOLE. Ph.D.

1929, the Year of Extremes of Rainfall.—In considering the rainfall of 1929 over the British Isles it is difficult to decide whether the dry period January to September or the wet October to December was the more remarkable. The rainfall of the first 9 months of the year, over the British Isles as a whole, was less than that of any other January to September in the last 60 years (although there was very little more in the similar periods of 1870, 1887 and 1921). On the other hand the rainfall of the last 3 months was greater than that of any other October to December, the general amount of 21·9in. being as much as 2·6in. more than that of the next wettest October to December, viz., that of 1872 with 19·3in. The computed values for the general rainfall for 1929, together with the averages for the period 1881 to 1915, are set out below:—

	January—September		October—December	
	Average	1929	Average	1929
	in.	in.	in.	in.
England and Wales	23·8	15·0	11·4	20·3
Scotland	34·2	27·9	16·1	23·8
Ireland	30·0	24·6	13·3	20·8
British Isles ...	28·2	20·4	13·2	21·9

It will be seen that the general deficiency over the British Isles at the end of September amounted to 7·8in. This was more than counterbalanced by the excessive rain of the last 3 months, which actually exceeded that of the whole of the first 9 months by 1·5in.

This compensation which Nature seems to provide, sooner or later, recalls the rainfall of 1879 and 1880, although then the contrast was not quite so striking. On that occasion the sequence was reversed, for the remarkably dry winter of 1879 to 1880 followed one of the wettest summers on record. The rainfall of the three months October to December on the average only amounts to 32 per cent. of the total for the year.

but in 1929 appreciably more than this proportion was recorded everywhere in the British Isles, except in Berwickshire. The last three months gave more than half the total rainfall of the year at stations representative of the whole of England and Wales, except the northeast, and over much of the Southern Uplands and Western Highlands of Scotland. Over a large area from Hereford to the Isle of Wight two-thirds of the total for the year fell in the last 3 months. For a few widely distributed stations the actual rainfall amounts for these two periods are set out below:—

Station	Jan.-Sept.	Oct.-Dec.	Station	Jan.-Sept.	Oct.-Dec.	Station	Jan.-Sept.	Oct.-Dec.
	in.	in.		in.	in.		in.	in.
London ...	10·2	12·4	Launceston ...	18·7	30·8	Douglas ...	21·5	23·7
(Camden Sq.)			Ross ...	10·3	19·9	Glasgow ...	20·1	20·1
Tunbridge Wells	10·9	20·2	Seathwaite ...	64·6	71·9	Lerwick ...	21·3	24·7
Selborne ...	12·2	26·4	Treherbert ...	39·6	64·9	Fort William	39·4	40·3
Oxford ...	7·6	14·8	Lake Vyrnwy	24·6	38·5	Dublin ...	13·9	13·3

At Seathwaite (Cumberland) the difference in the rainfall of the two half-years is even more striking, the total for January to June being 29·9in. and for July to December 106·6in., or nearly three and a half times as much.

The remarkable variations during the year are further demonstrated by the details of the monthly general rainfall, set out below, as a percentage of the average, 1881 to 1915:—

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
England and Wales	71	49	13	57	103	78	79	79	37	120	232	190
Scotland	49	54	24	76	107	124	108	139	73	144	130	168
Ireland	57	129	24	51	109	83	119	119	38	127	151	184
British Isles	63	67	18	61	105	91	96	104	47	128	188	183

Each of the first four months was dry, with the exception of February in Ireland. It is worthy of comment that prior to January, 1929, the last 11 Januaries, with one exception, experienced a rainfall in excess of the average over the British Isles generally. In passing it may also be mentioned that in the majority of cases of a dry January the calendar year has also given less than the average rainfall. Actually, the general rainfall over the British Isles for January has been less than the average on 26 occasions in the previous 60 years and in only 9 cases was the ensuing year wet. March, 1929, was everywhere unusually dry and over the British Isles as a whole the month was the driest March since before 1870 and ranks with February, 1891 and June, 1925, as the driest months in the last 60 years. At a few stations near London there was no rain at all during the month. The rainfall of the four summer months, May to August, approximated to the average over the

British Isles as a whole. England and Wales received rather less, and Scotland and Ireland rather more than the average amounts during these months. September was unusually dry, there being in the last 60 years only four drier Septembers over the country generally; of these, 1907 and 1910 were appreciably drier, and 1894 and 1895 slightly drier. Of the last three months November and December were the most remarkable. November was easily the wettest November over the British Isles as a whole, in spite of the fact that over the greater part of the northern half of Scotland the rainfall was below the average. In parts of the southwest of England the month was the wettest of any name in the last 60 years. The rainfall of December over the country as a whole was only exceeded by that of 1876, although December, 1914, was about as wet.

At Camden Square (London) there was no rain during 37 days from August 23rd to September 28th. The previous longest "absolute drought" since the record started there in 1858 was one of 29 days, from March 18th to April 15th, 1893, and again from June 27th to July 25th, 1921. The deficiency of rainfall was so persistent that many reservoirs, especially in the Midlands, became almost completely dry and water restrictions were enforced in many localities. On the other hand during the last 3 months of the year there were only 5 rainlesss days in the mountains of Connemara. Probably the heaviest rainfall of the year occurred during November 5th to December 13th at Pont Lluest Wen Reservoir, to the north of Pontypridd in South Wales, the total rainfall during 7 days amounted to 13·7in., 15 days 21·8in., 21 days 27·2in., 28 days 33·0in., 35 days 40·4in. and 39 days 43·8in, or practically half the amount which usually falls during a whole year at that station. At Rosthwaite in Borrowdale (Cumberland) 11·8in. was recorded during the 7 days November 5th to 11th. Serious flooding resulted in a number of districts, although the extent was certainly reduced by the dry state of the ground initially. It was most disastrous between Bridgwater and Taunton and in the Rhondda Valley. In the latter district the damage was accentuted by the deposition of the rubbish from coal tips in many houses, gardens, roads, etc. The initial cause was the heavy rain of November 11th, Armistice Day, which amounted to 8·31in. at Pont Lluest Wen Reservoir. So large an amount has been recorded in a rainfall day only on June 28th, 1917 (near Bruton, Somersetshire), and August 18th, 1924 (at Cannington, near Bridgwater), and the fall of 8·31in. for November 11th ranks as the largest on record either for winter months or for the mountainous parts of the country. The rainfall lasted for 18 hours and was noteworthy for its persistence and not for its intensity at any time. Subsequent heavy rains

resulted in further flooding in the Rhondda Valley. At Treherbert a measurement of 5·71in. was made for the 24 hours ending at 4 p.m. on November 19th.

While the incidence of the rainfall throughout the year was unprecedented, the annual totals everywhere approximated fairly closely to the average. Over more than half the country the annual totals were within 10 per cent. of the average. The greatest excesses occurred over the west of the land masses, associated with the unusually strong west and southwest winds experienced during the year. In most parts of Ireland the annual rainfall exceeded the average by small amounts. The largest values, rather more than 115 per cent., were recorded in the mountains of Kerry and in Connemara. In Great Britain more than the average occurred over the greater part of the southwest of Scotland, over most of Wales, and in England to the west of a line roughly from Penrith to Manchester, Rugby, Bath and Lyme Regis, as well as in the south from Southampton to Tunbridge Wells. There was more than 120 per cent. over much of the Devon-Cornwall peninsula, in South Wales, in Snowdonia, and in Islay in western Argyllshire. On the other hand rather less than 80 per cent. fell in Lincolnshire and in the neighbourhood of the Moray Firth. From information at present available the following general values for 1929 have been computed:—England and Wales 100 per cent., Scotland 103 per cent., Ireland 105 per cent. and British Isles 102 per cent. of the average 1881-1915.

At Camden Square (London) the total rainfall was 22·55in., or 1·92in. below the average for the year. A remarkable feature of the rainfall at that station was the small number of rain-days, a smaller total than 134 having been recorded in only 5 of the last 72 years.

The First Cold Spell of the Year

By S. T. A. Mirrlees, M.A.

The past year has been characterised, meteorologically, by much breaking of records. The unusually cold weather of the early part of the year helped to attract public attention to the subject of spells and periods, a peak of journalistic enthusiasm being reached in the proposal to substitute, for St. Swithin, Dr. Alexander Buchan. Apart from topical interest the choice of subject has been assisted by the fact that data lay ready to hand, these notes being based on figures prepared by Dr. Brooks and myself from the Kew Observatory records for an investigation into temperature variations.

The average temperature at Kew Observatory falls quickly in

autumn, the fall becoming slower in December, and the coldest part of the average year comes in mid-January. The thick line in Fig. 1 shows the part for December to February of the smoothed curve of the annual course of temperature; it is based on mean values for the years 1871-1910, and may be said to represent the "ideal" course of temperature in the absence of day-to-day perturbations. A curve of daily temperatures shows very irregular variations, and for the investigation mentioned above it was decided to smooth the daily mean temperatures in order to differentiate warm and cold spells from single warm or cold days. The smoothing was carried out by means of over-lapping 5-day means, that is, the temperature assigned to December 3rd, say, is the mean of December 1st-5th, to December 4th, the mean of December 2nd-6th, and so on. The dotted line in Fig. 1 is the curve of the smoothed daily mean temperatures for the period 1871-1910. A series of curves of smoothed temperatures from January to June of 1881-1923 was also plotted so that temperature variations in individual years could be examined.

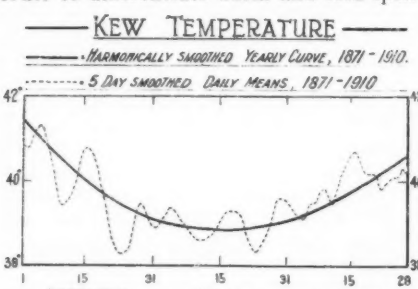


Fig. 1.

Fig. 1 gives at a glance an illustration of a remark in Dr. Buchan's original memoir*: "there are certain periods, more or less well defined, when the temperature instead of rising remains stationary or retrogrades; instead of falling, stops in its downward course, or even rises; and at other times falls or rises for a few days at a more accelerated speed than usual."

The irregularities in the dotted curve might represent tendencies for warm or cold spells to recur at the same time of year, and on this consideration one could deduce that a fall of temperature tends to set in about January 4th. It has however to be considered that a comparatively small number of outstandingly warm or cold periods which happened to fall about the same time would leave an impression on the curve of a spell for the whole period, and closer investigation is required. Taking for example January 24th, according to the dotted curve the coldest January day (actually the centre of the coldest 5-day spell, on the average, in January during the years in question) it is found that the mean temperatures for that day are, for the

* Edinburgh, J. Scot. Meteor. Soc., New Series, Vol. II., p. 4.

years 1871-1910, 38·3°F. for 1911-1927, 41·1°F. This example will show how the position of a hill or valley on the dotted curve depends on the period over which the mean is calculated; indeed it is a fair assumption that in a very long series of observations the dotted curve would coincide with the thick curve.

Everyone knows what is meant by a "cold spell," but the term has had no numerical limits assigned to it as is the case with, say, "absolute drought" in this country, or "cold wave" in the United States, where the definition includes not only the amount of drop in temperature, but also the season of the year and the district of the country. It is suggested that a spell should be classed as "cold" when the smoothed temperature falls below the normal (the thick curve) by an amount equal to or greater than $1\frac{1}{2}$ times the standard deviation of the mean smoothed temperature for the date concerned, that is by an amount which varies from about 9° on January 1st to 7° on February 28th and about 5° in June. Table I gives the date of

TABLE I.—DATE OF BEGINNING AND DURATION OF FIRST COLD SPELL OF THE YEAR (1881-1923).

Year	Date	Days	Year	Date	Days	Year	Date	Days
1881	Jan. 12	19	1896	Feb. 25	5	1910	May 7	8
2	June 13	5	7	Jan. 22	5	11	Apr. 3	9
3	Mar. 7	15	8	Mar. 24	8	12	Jan. 31	9
4	Apr. 15	16	9	Feb. 26	5	13	*	
5	May 5	10	1900	Feb. 7	11	14	*	
6	Jan. 6	5	1	Feb. 13	7	15	Mar. 26	8
7	Jan. 1	7	2	Feb. 10	13	16	Feb. 24	7
8	Jan. 31	5	3	Jan. 14	6	17	Jan. 25	25
9	Jan. 4	7	4	Feb. 27	8	18	Apr. 15	11
1890	Feb. 28	8	5	Apr. 19	5	19	Feb. 1	5
1	Jan. 4	13	6	Mar. 22	9	20	June 5	5
2	Jan. 10	5	7	Jan. 24	6	21	Apr. 15	7
3	Jan. 1	10	8	Jan. 11	5	22	Mar. 21	7
4	Jan. 1	12	9	Jan. 26	7	23	May 12	10
5	Jan. 26	28						

* No cold spell Jan.-June.

occurrence of the first cold spell determined on this basis, for each year from 1881-1923 and also the number of days over which the spell continued. The duration of each spell is found from the curves for individual years, by adding 4 to the appropriate number of 5-day means which come within the prescribed limit.

Table II shows the frequency of occurrence of the first cold spell of the year in the various months from January to June, and

also the percentage frequencies in the periods 1881-1894, 1895-1908 and 1909-1923 considered separately.

The tables indicate no tendency for a cold spell to set in about a particular date but point to a series of generally milder winters from 1909-1923. The inquiry has not yet been completed for the years 1924-1929 but as regards 1924-1927 the only cold spell in January was in 1926. It is interesting to note that although January 1929 was the coldest in many parts of the

TABLE II.—FREQUENCY WITH WHICH FIRST COLD SPELL OCCURS IN VARIOUS MONTHS.

	Frequency 1881-1923	Percentage Frequency		
		1881-1894	1895-1908	1909-1923
January	17	64	36	20
February	9	7	43	13
March	5	7	14	14
April	5	8	7	20
May	3	7	—	13
June	2	7	—	7
No spell January—June ...	2	—	—	13

British Isles since 1917 the Kew temperatures were not low enough to qualify for a cold spell, on the above basis; the smoothed temperature curve remained at 33°-35° during most of the month, after which a milder period was experienced until the memorable cold spell of February set in.

The definition of "cold" adopted connotes smoothed mean temperature below freezing point up about February 10th, so that Table I suggests that the need for protecting London's water supply from frost was more evident twenty or thirty years ago. Were those the old-fashioned winters?

Discussions at the Meteorological Office

The subjects for discussion for the next two meetings will be:—

January 27th.—*Atmospheric ozone: its relation to some solar and terrestrial phenomena.* By F. E. Fowle (Smithsonian Misc. Coll., 81, No. 11, 1929). *Opener*—Mr. J. S. Dines, M.A.

February 10th.—*Some thundercloud problems.* By C. T. R. Wilson (Philadelphia, Pa. J. Franklin Inst., 208, 1929, pp. 1-12). *Opener*—Mr. E. A. Cope, B.Sc., A.R.C.S.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday,

December 18th, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, D.Sc., President, in the Chair.

J. Edmund Clark, B.A., and I. D. Margary, M.A.—Floral Isophenes and Isakairs.

Dates of first flowering of certain widely distributed plants have been collected by the Society with the help of voluntary observers all over the British Isles since 1890. The results of these observations can often be best interpreted by presentation in map form, and this was first attempted with the Society's data in 1916. The mean date of flowering of 12 plants, ranging from hazel in January to greater bindweed in July, was given for as many observing stations as possible. Lines of equal flowering date (isophenes) were then drawn on the map through stations of equal date, thus disclosing areas in which plants flowered definitely later or earlier than in neighbouring areas. Eventually it became possible to prepare a map showing the average distribution of these dates and isophenes, and this was done for the 30 years 1891-1920 and for the 35 years 1891-1925, the two maps proving so closely similar that it was clear that the averages thus obtained were reasonably reliable and fixed. It is now possible therefore to compare the annual isophene map with the average map and to prepare from it a map showing for that year the variations from the average in all parts of the country. Lines are drawn through points of equal variation defining areas of real earliness or lateness and are called "Isakairs" (equal unseasonableness). Maps so prepared are more instructive than the original isophene maps, for these are based on the original observations which are always dependent on altitude, latitude, etc., in addition to the changing weather factors. In the isakair maps these constant influences are removed and the relation of weather to plant growth can thus be more readily followed. Isakair maps have been prepared for every year from 1891 and are being published together with the isophene maps upon which they are based. They show the general distribution and degree of earliness and lateness in the first eight months of each year, and form a unique series for such information. Local effects of abnormal weather are shown clearly in some instances (*e.g.*, marked lateness in England southwest in 1905 and 1907 due mainly to very deficient sunshine rather than to low temperature) but it must be remembered that these maps show the mean effect of 8 months during which weather conditions suffer marked changes. Much more definite relations between the isakairs and weather would be seen if shorter periods such as a month could be taken, but it has not yet been possible to undertake the somewhat lengthy preparation involved although the data are all available for anyone willing to undertake it.

Sir Gilbert T. Walker, C.S.I., F.R.S.—On the mechanism of tornadoes.

The prevailing idea that the area of a tornado is roughly vertical has been opposed by Wegener, who maintained that it is horizontal. In this paper it is urged that while Wegener's evidence against a vertical axis is conclusive he does not provide an adequate explanation of a horizontal direction, and that the rotation of the earth will, when convergence occurs, set up a spin parallel to its axis. This view is supported by the almost universal anti-clockwise rotation of tornadoes in the northern hemisphere and, in general, by the photographic evidence.

E. W. Bliss, M.A.—A study of rainfall in the West Indies.

The rainfall in the eastern islands of the West Indies is related to the circulation of the North Atlantic during the months March to May preceding, and is deficient when the circulation is more vigorous than usual; there is a close relationship with temperature in the Cape Verde Islands, and low temperatures tend to be followed by deficient rainfall. In addition the rainfall in this part of the West Indies belongs to the first group of the southern oscillation.

Correspondence

To the Editor, *The Meteorological Magazine*.

Sixteenth Century Weather

Mr. Richard Cooke's communication under the above heading in the November issue of the *Meteorological Magazine* recalls the account given by Atkyns, the historian of Gloucestershire in the XVIIIth century, of the tragic results of a visitation by ball lightning at Little Sodbury Manor. He says:—

> "In 1556 died Maurice Walsh Esq. together with seven of his children occasioned by a fiery sulphureous globe rolling in at the parlour door at dinner time which struck one dead at the table and caused the death of the rest. It made its passage through a window on the other side of the room."

CICELY M. BOTELEY.

Guildables, 17, Holmesdale Gardens, Hastings. November 21st, 1929.

The Green Flash

With reference to the letter on p. 207 of the *Meteorological Magazine* for October, 1929, the following remarks may be of interest.

Many of the people one has met in Jaffa are familiar with the "green flash," and I too have seen it on several occasions when on the beach near Jaffa. As in the letter referred to, the sun right down on the horizon retains its brilliant orange-yellow

colour until just as the last portion disappears a bright green "spot" is seen, which, to me, has always appeared as a small disc of green light and lasts about a quarter of a second.

One evening when expecting to see this flash, a party of four of us, including two doctors, had discussed the possibility of this phenomenon being due to some effect in one's eyes and not to refraction*: to try this out two of us watched the sun carefully until it had set, while the other two looked eastwards and on a signal from the sun watchers turned quickly just as the sun was disappearing. The two who had watched continuously saw the green flash, while to those who did not look till the very last moment, the sun went down orange-yellow, and no green was seen.

No further opportunities have arisen to try this experiment again and with other observers.

C. VAUGHAN STARR.

R.A.F. Station, Amman, Transjordan. November 11th, 1929.

Waterspout at Holyhead

At 9h. 48m. G.M.T. on the 14th of this month, what seemed to be a waterspout was observed at a distance of about three miles across the bay to the northeast of this station.

The state of the sea was slight and the wind light from the SW. The sky was clouded with cumulo-nimbus, cumulus and cirrus, the cumulo-nimbus being mostly to the north of the station. The visibility was good; showers of rain were occurring in the immediate vicinity and a rainbow was observed to the northnortheast.

From the base of the cumulo-nimbus there hung a strip of cloud not unlike a mare's tail. The surface of the sea immediately below this strip of cloud was seen to be disturbed and what seemed to be a vaporous mist was observed to be rising to meet the hanging strip of cloud. The sea disturbance was very distant, the heavy cumulo-nimbus casting a deep shadow over the sea. The phenomenon was of only a few minutes' duration and was observed to have moved eastwards on to the land.

W. I. JONES.

Salt Island, Holyhead. November 29th, 1929.

NOTES AND QUERIES

Thunderstorm at "Warm Front" of a Depression

A thunderstorm experienced at Valentia Observatory between 14h. 15m. and 14h. 25m. on Saturday, November 9th, is note-

* *See* "The Green Flash at Sunrise," by W. L. Balls. *Nature CXX*, 1927, *p.* 728.

worthy in that it occurred at what appears to be the " warm front " of a depression.

Reproductions of the anemogram and thermogram (enlarged scale) for the afternoon and evening of November 9th are shown in the frontisp iece of this number of the magazine. It will be seen that a " cold front " reached Valentia shortly before 19h. : this and the steadiness in direction and velocity of the wind from just before 15h. to 18h. 45m. as compared with the variations before and after indicate that Valentia was in the " warm sector " during that period. The thermogram showing an increase of temperature at about 15h. 5m. and a nearly constant temperature from that time until 19h. gives further evidence that Valentia was in the warm sector from about 15h. to 19h. Alto-stratus cloud was observed at 7h., 9h., 15h., 16h., and 18h. on the day in question. Another interesting feature shown in the illustration is that the wind was decidedly stronger in the " warm sector " than it was in the " cold sector."

Rainfall was also peculiar in that only a few drops of rain fell at the Observatory during the thunderstorm. The appearance of the sky, however, suggested that heavy rain was falling to the northwest where the storm seemed to be centred. Heavy rain fell at the passage of the " cold front," as much as 13mm. having been recorded in the hour and a half 18h. to 19h. 30m.

M. T. SPENCE.

Climatic Changes in Greenland

The account of the Oxford University Expedition to Greenland, published by Dr. T. G. Longstaff in the *Geographical Journal* for July, 1929, adds a few further details to the evidence for climatic change in Greenland in the Middle Ages. The paper contains a chart of the old Norse settlements near Ilulialik north-east of Godthaab (about 64°45′N., 50°30′W.). Dr. Longstaff considers that Ilulialik represents the zone of local climatic optimum at the present time, but the main centre of the Norse population was nearer the ice-sheet. " Even in July we found it impossible to reach these settlements (where horses, sheep and possibly cattle are supposed to have been kept), owing to the masses of ice carved from the glaciers flowing into the sea from the inland ice . . . . It was perfectly obvious that no settlers could get there, much less live there, under present conditions and that some deterioration of climate must have taken place since those times."

The suggestion that the zone of climatic optimum has shifted seaward is very interesting, and fits in with a plausible reconstruction of the course of events. In other parts of the world the " climatic optimum " of Christian times seems to have occurred about the seventh to tenth centuries. If similar conditions extended to Greenland, the edge of the inland ice must

have retreated considerably, and the Norse settlement must have about coincided with the time when this ice edge in west Greenland occupied its most easterly limit. Meanwhile, however, the amount of drift ice off the coast was increasing, and the coastal regions were becoming colder and less hospitable. The net result would therefore have been that in the eleventh to thirteenth centuries the climatic optimum lay further east than at present. After the fourteenth century the change of climate was reflected in the renewed growth and westward advance of the inland ice, and the climatic optimum shifted westward again, as noted by Dr. Longstaff.

C. E. P. Brooks.

The Effect of Changes in the Density of the Air on the Readings of the Pressure Tube Anemograph.

In the pressure tube anemograph, a record of the velocity of the wind is obtained by transmitting to the recording apparatus the difference between the pressure set up by the wind in an open tube facing the wind and the resultant of the pressures in a vertical tube pierced with uniformly spaced small holes. The latter is a suction effect and the difference of pressure actually available is, therefore, the arithmetical sum of the two pressures. The pressure due to a stream of fluid is proportional to its density and to the square of the velocity. Consequently, if the pressure effect is utilised to measure the velocity, account must be taken of the density of the fluid. In the pressure tube anemograph, the fluid with which we are concerned is the air, and the charts for the standard pattern anemographs employed at Meteorological Office stations are graduated on the assumption that the density of the air has the standard value 1226 g/m^3.

If the density of the air changes from the standard value ρ_0 to some other value ρ the velocity of the air V required to produce the same pressure as air having the standard density and moving at the velocity V_0 is given by the equation :—

$$V = V_0 \sqrt{\rho_0/\rho}$$

Near sea level the variations of density which occur as a result of changes of pressure and temperature are small and it is ordinarily not necessary to take account of them. Again, the mean density at various places on the earth's surface is, in general, sufficiently close to the standard value to render it unnecessary to apply corrections. If, however, an anemometer is installed at a considerable height above sea level, the mean density may be sufficiently below the standard density to produce serious errors. The following table gives the value of the ratio $\sqrt{\rho_0/\rho}$ at various heights above the earth's surface and

may be used for the correction of the readings of pressure tube anemographs installed at those heights. It will be seen that the correction required is about 1½ per cent. at 1,000 feet and 3 per cent. at 2,000 feet. It should be noted that the densities used in computing these factors are the standard densiies adopted by the International Commission for Air Navigation (I.C.A.N.). To be strictly accurate, the actual mean density at the place where the instrument is installed should be used in computing the correction, but it is unlikely that the actual density would anywhere differ sufficiently from the I.C.A.N. value to make such a refinement worth while.

Feet			$\sqrt{\rho_0/\rho}$	Feet			$\sqrt{\rho_0/\rho}$
1,000	...	...	1·015	6,000	...	...	1·094
2,000	...	...	1·030	7,000	...	...	1·111
3,000	...	...	1·045	8,000	...	...	1·128
4,000	...	...	1·061	9,000	...	...	1·146
5,000	...	...	1·077	10,000	...	...	1·164

Reviews

Karten der Atmosphärischen Zirkulation auf der Nördlichen Halbkugel vom 1 *Jänner bis* 31 *März*, 1910. By Felix M. Exner. Edited by the Zentralanstalt für Meteorologie und Geodynamik. Size 14½ × 11in. Vienna, 1929.

For the purpose of studying in detail the circulation of warm and cold air masses, Professor Exner has compiled and published a series of daily charts for the northern hemisphere covering the first three months of 1910. Two charts are given at each opening; on the left is the distribution of pressure shown by 10-millimetre isobars, on the right is the temperature anomaly in steps of 5°C. The anomaly or difference from normal is employed because it is a better indication of the polar or equatorial origin of the air than is the actual temperature This fine series of charts should prove of great assistance in studies of the birth and development of barometric depressions

Elementary Applications of statistical Method. By H. Banister, Ph.D. Size 7¼ × 4¾in., pp. 56. *Illus.* London: Blackie and Son Ltd., 1929. 3s. 6d.

This little book will be useful to those who wish to make occasional use of statistical methods without requiring a knowledge of the theory or the use of highly refined methods. It deals in an elementary way with frequency distributions and the goodness of fit between observed and calculated data, measures of dispersion, the significance of the mean and simple correlation. The only type of frequency distribution referred to is the binomial, and the symmetrical binomial distribution is misleadingly called the " normal " distribution. The distribution

based on the normal law of errors, to which the term " normal frequency distribution " is customarily applied, is not even mentioned. In meteorological statistics this distribution is far more important than the binomial, which rarely occurs. The criteria of goodness of fit and significance are shown graphically in four very useful diagrams.

Partial correlation is not discussed; it is admittedly a difficult subject to handle simply, but one cannot help thinking that the four pages given up to logarithmic tables, which most people possess already, could have been more usefully devoted to the elements of the subject.

News in Brief

It was announced in the list of New Year Honours that Mr. H. L. B. Tarrant, Chief Clerk of the Meteorological Office, and Mr. E. W. G. Twentyman, Harbour Master and Meteorological Observer at Suva, Fiji, have been made Members of the Order of the British Empire

A paper on " The areas covered by intense and widespread falls of rain," by Mr. J. Glasspoole, Ph.D., was read before the Institution of Civil Engineers on December 17th, 1929, and evoked an interesting discussion.

The Weather of December, 1929

Stormy unsettled weather with much rain and sun prevailed throughout the greater part of December. At Valentia it was the wettest December on record and at Ross-on-Wye the wettest since 1876. Pressure was continuously low south of Iceland from the 1st to 14th and intense secondary depressions swept quickly northeast across the country. Heavy falls of rain were monotonously frequent in many parts of the country with 24hr. totals of 1in. or more locally on many days; 2·65in. at Fofanny (Co. Down) on the 1st, 2·20in. and 2·29in. at Tynywaum (Glamorgan) on the 7th and 13th, and 1·79in. and 1·75in. at Holne (Devon) on the 6th and 7th were among the larger falls. But the outstanding feature of the month was the persistence of severe gales which were of almost daily occurrence. Between the depressions there were intervals of bright weather, the sunniest days of the first half of the month being the 3rd, 4th, 10th and 12th, when about 5hrs. bright sunshine were recorded at many places. Thunder was heard occasionally, the southern districts experiencing heavy thunderstorms during the evening of the 6th and northern England on the 8th and 9th. Temperature was high throughout this period, maxima being usually about or above 50° over the kingdom generally while 58°F. was reached at Dublin on the 13th, and at Cambridge, Kew, Margate and

Norwich on the 14th. After the 14th there was a change to fair anticyclonic conditions and temperature fell generally on the 15th and 16th to a seasonable level with minimum readings in the screen below freezing point, and severe ground frosts, 11°F. being recorded at Rhayader on the 17th, 13°F. at Burnley on the 16th. The days, however, were relatively warm with much sunshine, over 7hrs. being recorded locally in south England on the 19th. On that day pressure fell generally over the whole country and unsettled weather spread from the west. Snow or sleet fell in Scotland and northern England from the 20th to 23rd, lying locally to a depth of 1 to 2 inches, and maximum temperatures on the 20th-22nd were round 35°F. generally; 22°F. was recorded at Harrogate and 33°F. at Durham and Ross-on-Wye on the 22nd. Gales occurred at many places during these days and fog locally in north England on the 21st. On the 23rd there was a renewal of mild rainy weather with gales, severe locally, on the 25th, 28th and 29th. The heaviest rain of the month was experienced on the 28th, when 3·30in. fell at Rosthwaite (Cumberland), 3·11in. at Oughtershaw (Yorkshire), and 3·06in. at Dungeon Ghyll (Westmorland). The year closed, however, with a mainly fine quiet day. The distribution of sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs).
Stornoway	22	— 1	Valentia	34	— 7
Aberdeen	49	+13	Liverpool	70	+27
Dublin	76	+28	Falmouth	75	+20
Birr Castle	54	+11	Kew	63	+26

Pressure was below normal over the whole of northwest Europe, Iceland and Spitsbergen, the greatest deficit being 17·4mb. at Reykjavik, and above normal over Italy, the Iberian Peninsula, the Azores, Newfoundland and Bermuda, the greatest excess being 4·2mb. at Gibraltar. Temperature was above normal over the whole of western Europe, being as much as 18°F. in excess in Lapland. Rainfall was above normal in western Europe except for the extreme north of Scandinavia. In northeastern Norrland it was three times the normal.

Gales and heavy rain in France, the Netherlands and the Bay of Biscay from the 6th to 8th caused much damage to buildings, communications and shipping. Weather in Berlin about the 15th was reported to be the mildest experienced at this season of the year for over 50 years. Severe cold occurred in France and Switzerland from about the 21st, and snow fell heavily in Switzerland and eastern Europe down to sea level. This spell, however, was broken on Christmas Eve, when a gale of warm föhn wind began blowing accompanied by heavy rainfall up to 6,000ft. All the rivers rose rapidly and floods occurred in the low country. Severe gales were again experienced over Switzer-

land, west Germany, the Netherlands and northern France on the 28th to 30th. Part of the town of Havre was inundated by a great wave, and a landslide occurred at Boulogne. Temperature rose above 60°F. in the lower parts of Switzerland on the 29th. Considerably more than normal sunshine was experienced at Cannes during December. Owing to the severe weather conditions in Swedish Lapland, where the "reindeer moss" became covered with snow solidly frozen, herds of reindeer migrated south.

Heavy snow fell in Shanghai and throughout the Yangtze Valley on the 21st. The snow lay 18in. deep in Nanking. Nearly 200 Chinese were drowned when a local steamer foundered in a gale off Fukien Point on the 21st. A severe hurricane passed over the Fiji Islands on the 11th and 12th, during which 16 lives were lost and 7 ships wrecked. Heavy floods resulted, doing much damage to the sugar, copra and banana industries.

Gales were experienced over New Zealand on the 16th. Widespread heavy rain of great benefit to the graziers occurred over the northern pastoral areas of South Australia near the end of the month. By the 31st floods had occurred in some parts.

The central and prairie provinces of Canada experienced a spell of severe cold during the middle of the month. One of the worst December blizzards was reported from Ontario between the 18th and 22nd, while snowstorms occurred generally in the central provinces. In the U.S.A. a severe storm of glazed frost following 24 hours' rain was experienced in the northern States about the same time. 25in. of snow were measured at Marquetta, Michigan, and much damage was done to trees and wires by the weight of the ice. Snow fell as far south as New Orleans and northern Florida. Before this temperature had been considerably above the normal over the whole of the States and precipitation about normal.

Severe gales were experienced frequently on the North Atlantic causing several wrecks.

The special message from Brazil states that the rainfall was plentiful in the northern and central regions with 2·24in. and 1·10in. above normal respectively, and scarce in the southern regions with 0·59in. below normal. Five small anticyclones passed across the country. The crops were generally in good condition. At Rio de Janeiro pressure was 2·0mb. below normal and temperature 3·8°F. above normal, the last decade being exceptionally warm.

Rainfall, 1929—General Distribution

	Dec.	Year	
England and Wales ...	190	100	per cent of the average 1881-1915.
Scotland	168	103	
Ireland	184	105	
British Isles	183	102	

Rainfall: December, 1929: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent of Av.
Lond.	Camden Square	1·19	175	*Leics.*	Belvoir Castle	4·02	163
Sur.	Reigate, Alvington	7·93	249	*Rut.*	Ridlington	4·47	...
Kent.	Tenterden, Ashenden	7·70	247	*Linc.*	Boston, Skirbeck	4·00	186
,,	Folkestone, Boro. San.	6·12	...	,,	Lincoln	3·56	162
,,	Margate, Cliftonville	3·80	167	,,	Skegness, Marine Gdns	4·54	206
,,	Sevenoaks, Speldhurst	6·20	...	,,	Louth, Westgate	5·12	183
Sus.	Patching Farm	6·10	181	,,	Brigg, Wrawby St.	4·26	...
,,	Brighton, Old Steyne	5·95	292	*Notts.*	Worksop, Hodsock	4·33	183
,,	Heathfield, Barklye	8·75	236	*Derby.*	Derby, L. M. & S. Rly.	3·80	146
Hants.	Ventnor, Roy. Nat. Hos.	5·84	177	,,	Buxton, Devon Hos.	9·69	171
,,	Fordingbridge, Oaklnds	7·72	195	*Ches.*	Runcorn, Weston Pt.	4·16	132
,,	Ovington Rectory	...	...	,,	Nantwich, Dorfold Hall	4·68	...
,,	Sherborne St. John	6·43	195	*Lancs.*	Manchester, Whit. Pk.	6·03	186
Berks.	Wellington College	3·61	125	,,	Stonyhurst College	8·66	178
,,	Newbury, Greenham	7·88	246	,,	Southport, Hesketh Pk	5·62	174
Herts.	Welwyn Garden City	4·57	...	,,	Lancaster, Strathspey	7·55	...
Bucks.	High Wycombe	6·38	217	*Yorks.*	Wath-upon-Dearne	4·33	183
Oxf.	Oxford, Mag. College	4·42	191	,,	Bradford, Lister Pk.	7·38	221
Nor.	Pitsford, Sedgebrook	4·89	202	,,	Oughtershaw Hall	15·68	...
,,	Oundle	2·77	...	,,	Wetherby, Ribston H.	5·25	214
Beds.	Woburn, Crawley Mill	4·56	195	,,	Hull, Pearson Park	3·84	159
Cam.	Cambridge, Bot. Gdns.	3·16	167	,,	Holme-on-Spalding	4·60	...
Essex.	Chelmsford, County Lab	4·26	192	,,	West Witton, Ivy Ho.	7·84	...
,,	Lexden Hill House	4·07	...	,,	Felixkirk, Mt. St. John	4·51	187
Suff.	Hawkedon Rectory	4·22	174	,,	Pickering, Hungate	4·42	...
,,	Haughley House	3·79	...	,,	Scarborough	4·43	186
Norf.	Norwich, Eaton	4·93	188	,,	Middlesbrough	2·51	129
,,	Wells, Holkham Hall	4·71	229	,,	Baldersdale, Hury Res.	8·39	234
,,	Little Dunham	4·83	198	*Durh.*	Ushaw College	4·07	163
Wilts.	Devizes, Highclere	7·33	240	*Nor.*	Newcastle, Town Moor	2·94	124
,,	Bishops Cannings	6·67	203	,,	Bellingham, Highgreen	5·71	...
Dor.	Evershot, Melbury Ho.	11·18	216	,,	Lilburn Tower Gdns.	4·64	...
,,	Creech Grange	7·19	...	*Cumb.*	Geltsdale	6·64	...
,,	Shaftesbury, Abbey Ho.	5·24	145	,,	Carlisle, Scaleby Hall	5·28	164
Devon.	Plymouth, The Hoe	7·68	154	,,	Borrowdale, Seathwaite	24·02	147
,,	Polapit Tamar	10·61	207	,,	Borrowdale, Rosthwaite	22·26	...
,,	Ashburton, Druid Ho.	...	...	,,	Keswick, High Hill	12·82	...
,,	Cullompton	8·36	190	*Glam.*	Cardiff, Ely P. Stn.	8·39	164
,,	Sidmouth, Sidmount	6·49	165	,,	Treherbert. Tynywaun	24·05	...
,,	Filleigh, Castle Hill	8·82	...	*Carm.*	Carmarthen Friary	12·98	226
,,	Barnstaple N. Dev. Ath.	6·62	149	,,	Llanwrda	14·38	205
Corn.	Redruth, Trewirgie	10·43	167	*Pemb.*	Haverfordwest, School	12·53	...
,,	Penzance, Morrab Gdn.	8·65	152	*Card.*	Aberystwyth	7·57	...
,,	St. Austell, Trevarna	9·37	154	,,	Cardigan, County Sch.	10·36	...
Soms.	Chewton Mendip	9·21	171	*Brec.*	Crickhowell, Talymaes	11·00	...
,,	Long Ashton	8·08	...	*Rad.*	Birm W. W. Tyrmynydd	15·86	193
,,	Street, Millfield	5·72	...	*Mont.*	Lake Vyrnwy	15·48	225
Glos.	Cirencester, Gwynfa	7·27	217	*Denb.*	Llangynhafal	5·71	...
Here.	Ross, Birchlea	6·52	219	*Mer.*	Dolgelly, Bryntirion	10·77	157
,,	Ledbury, Underdown	6·39	228	*Carn.*	Llandudno	5·96	192
Salop.	Church Stretton	8·07	238	,,	Snowdon, L. Llydaw 9	...	...
,,	Shifnal, Hatton Grange	4·39	171	*Ang.*	Holyhead, Salt Island	6·50	156
Worc.	Ombersley, Holt Lock	4·97	190	,,	Lligwy	5·77	...
,,	Blockley	7·08	...	*Isle of Man*			
War.	Farnborough	7·50	255		Douglas, Boro' Cem.	8·47	171
,,	Birminghm, Edgbaston	5·34	198	*Guernsey*			
Leics.	Thornton Reservoir	4·73	195		St. Peter P't. Grange Rd.	7·58	185

Rainfall: December, 1929: Scotland and Ireland

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent of Av.
Wigt.	Stoneykirk, Ardwell Ho	..	...	*Suth.*	Loch More, Achfary	11·20	121
,, .	Pt. William, Monreith	...	...	*Caith.*	Wick	5·60	182
Kirk.	Carsphairn, Shiel	19·34	...	*Ork.*	Pomona, Deerness	5·71	136
,, .	Dumfries, Cargen	8·96	165	*Shet.*	Lerwick	8·13	170
Dumf.	Eskdalemuir Obs.	12·90	184	*Cork.*	Caheragh Rectory	12·40	...
Roxb.	Branxholm	7·81	213	,, .	Dunmanway Rectory	14·72	183
Selk.	Ettrick Manse	...	...	,, .	Ballinacurra	7·88	154
Peeb.	West Linton	6·56	...	,, .	Glanmire, Lota Lo.	10·64	194
Berk.	Marchmont House	3·34	119	*Kerry.*	Valentia Obsy.	11·62	175
Hadd.	North Berwick Res.	2·37	110	,, .	Gearahameen	20·60	...
Midl.	Edinburgh, Roy. Obs.	3·82	178	,, .	Killarney Asylum	12·29	169
Ayr.	Kilmarnock, Agric. C.	8·41	197	.. .	Darrynane Abbey	9·45	161
,, .	Girvan, Pinmore	11·61	194	*Wat.*	Waterford, Brook Lo.	8·53	182
Renf.	Glasgow, Queen's Pk.	8·74	203	*Tip.*	Nenagh, Cas. Lough	8·80	191
,, .	Greenock, Prospect H.	15·58	197	,, .	Roscrea, Timoney Park	7·15	...
Bute.	Rothesay, Ardencraig	11·17	205	.. .	Cashel, Ballinamona	8·21	189
,, .	Dougarie Lodge	13·08	...	*Lim.*	Foynes, Coolnanes	9·29	196
Arg.	Ardgour House	18·34	...	,, .	Castleconnel Rec.	7·95	...
,, .	Manse of Glenorchy	19·59	...	*Clare.*	Inagh, Mount Callan	12·56	...
,, .	Oban	12·05	...	,, .	Broadford, Hurdlest'n.	8·47	...
,, .	Poltalloch	12·28	192	*Wexf.*	Newtownbarry	10·45	...
,, .	Inveraray Castle	...	...	,, .	Gorey, Courtown Ho.	8·79	230
,, .	Islay, Eallabus	11·93	201	*Kilk.*	Kilkenny Castle	7·48	216
,, .	Mull, Benmore	18·80	...	*Wic.*	Rathnew, Clonmannon	8·92	...
,, .	Tiree	...	...	*Carl.*	Hacketstown Rectory	8·48	207
Kinr.	Loch Leven Sluice	4·56	116	*Leix.*	Blandsfort House	7·85	213
Perth.	Loch Dhu	19·45	180	,, .	Mountmellick	7·99	...
,, .	Balquhidder, Stronvar	...	...	*Offly.*	Birr Castle	6·50	197
,, .	Crieff, Strathearn Hyd.	6·85	153	*Dubl.*	Dublin, FitzWm. Sq.	6·09	245
,, .	Blair Castle Gardens	9·03	236	,, .	Balbriggan, Ardgillan	5·83	201
,, .	Dalnaspidal Lodge	14·01	186	*Mo'th.*	Beauparc, St. Cloud	5·53	...
Angus.	Kettins School	6·04	201	,, .	Kells, Headfort	6·25	164
,, .	Dundee, E. Necropolis	3·63	136	*W.M.*	Moate, Coolatore	5·43	...
,, .	Pearsie House	6·85	...	,, .	Mullingar, Belvedere	6·51	177
,, .	Montrose, Sunnyside	4·60	166	*Long.*	Castle Forbes Gdns	7·46	187
Aber.	Braemar, Bank	8·50	239	*Gal.*	Ballynahinch Castle	11·52	154
,, .	Logie Coldstone Sch.	4·85	173	,, .	Galway, Grammar Sch.	7·04	...
,, .	Aberdeen, King's Coll.	6·54	203	*Mayo.*	Mallaranny	...	...
,, .	Fyvie Castle	...	..	,, .	Westport House	8·59	149
Moray.	Gordon Castle	3·91	145	,, .	Delphi Lodge	17·82	...
,, .	Grantown-on-Spey	2·65	98	*Sligo.*	Markree Obsy.	7·95	168
Nairn.	Nairn, Delnies	2·03	91	*Cav'n.*	Belturbet, Cloverhill	5·93	160
Inv.	Kingussie, The Birches	5·55	...	*Ferm.*	Enniskillen, Portora	...	...
,, .	Loch Quoich, Loan	19·75	135	*Arm.*	Armagh Obsy.	5·88	188
,, .	Glenquoich	22·78	155	*Down.*	Fofanny Reservoir	15·01	...
,, .	Inverness, Culduthel R.	2·70	...	,, .	Seaforde	8·90	216
,, .	Arisaig, Faire-na-Squir	7·92	...	,, .	Donaghadee, C. Stn.	6·99	219
,, .	Fort William	16·28	...	,, .	Banbridge, Milltown	5·07	...
,, .	Skye, Dunvegan	9·13	...	*Antr.*	Belfast, Cavehill Rd.	7·46	...
R & C.	Alness, Ardross Cas	4·05	98	,, .	Glenarm Castle	10·70	...
,, .	Ullapool	5·42	...	,, .	Ballymena, Harryville	7·08	159
,, .	Torridon, Bendamph	13·47	132	*Lon.*	Londonderry, Creggan	7·16	163
,, .	Achnashellach	13·06	...	*Tyr.*	Donaghmore	7·95	...
,, .	Stornoway	7·69	123	,, .	Omagh, Edenfel	7·71	182
Suth.	Lairg	6·74	...	*Don.*	Mulin Head	6·80	...
,, .	Tongue	6·20	125	,, .	Dunfanaghy	7·97	...
,, .	Melvich	12·69	295	,, .	Killybegs, Rockmount	10·56	145

Climatological Table for the British Empire, July, 1929.

STATIONS	PRESSURE		TEMPERATURE							Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION			BRIGHT SUNSHINE	
			Absolute		Mean Values				Mean							
	Mean of Day M.S.L.	Diff. from Normal	Max.	Min.	Max.	Min.	½ max. and min.	Diff. from Normal	Wet Bulb			Am'nt	Diff. from Normal	Days	Hours per day	Percentage of possible
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0—10	in.	in.			
London, Kew Obsy.	1017·5	+ 1·7	87	47	73·6	54·5	64·1	+ 1·4	55·5	77	5·4	2·59	+ 0·42	10	8·3	51
Gibraltar	1017·3	+ 0·5	91	63	84·1	67·9	76·0	+ 1·2	66·1	80	3·6	0·00	− 0·03	0	..	..
Malta	1017·4	+ 2·1	95	64	84·4	71·5	77·9	− 0·4	69·6	67	0·7	0·00	− 0·05	0	12·5	88
St. Helena	1016·6	+ 2·8	60	52	56·9	53·9	55·4	− 3·6	54·6	91	9·5	4·83	+ 0·80	23	..	..
Sierra Leone	1014·3	+ 1·6	86	..	81·7	72·5	77·1	− 1.5	74·8	90	6·6	15·11	+ 9·53	29	..	..
Lagos, Nigeria	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kaduna, Nigeria	1015·6	+ 1·6	87	63	83·1	66·5	74·8	+ 1·2	69·3	82	..	8·77	+ 0·57	19	..	..
Zomba, Nyasaland	1017·8	− 0·7	77	46	72·6	53·0	62·8	+ 0·8	..	70	4·4	0·47	+ 0·12	2	..	..
Salisbury, Rhodesia	1019·3	+ 0·1	75	36	70·3	43·7	57·0	+ 0·9	49·2	51	1·2	0·02	− 0·01	2	9·5	85
Cape Town	1022·6	+ 1·3	74	38	61·5	46·6	54·1	− 0·6	48·0	90	5·1	3·89	+ 0·27	15	..	..
Johannesburg	1023·9	− 0·4	68	29	61·2	41·8	51·5	+ 1·0	40·3	51	1·5	0·02	− 0·31	1	9·1	85
Mauritius	1020·5	+ 0·1	77	56	73·6	61·9	67·7	− 0·6	64·6	74	4·6	2·22	− 0·27	23	7·2	65
Bloemfontein	..	..	..	..	..	..	..	..	..	..	..	0·88	+ 0·50	..	..	..
Calcutta, Alipore Obsy.	996·9	− 2·3	97	76	88·2	78·8	83·5	0·0	79·1	91	9·2	11·14	− 1·37	24*	..	..
Bombay	1003·1	− 0·8	89	75	85·9	77·5	81·7	+ 0·4	77·5	86	9·4	16·08	− 8·19	20*	..	..
Madras	1003·9	− 0·6	104	74	98·6	80·0	89·3	+ 1·9	74·6	59	7·1	1·93	− 2·01	7*	..	..
Colombo, Ceylon	1009·8	+ 0·6	86	74	84·7	77·1	80·9	− 0·2	76·8	79	8·2	2·00	− 4·43	14	6·7	54
Hongkong	1003·2	− 1·6	92	74	85·9	78·1	82·0	− 0·5	78·5	83	8·1	22·70	+ 9·32	22	5·7	43
Sandakan	..	..	91	74	88·7	74·8	81·7	− 0·1	77·5	87	..	7·89	+ 1·34	12	..	..
Sydney, N.S.W.	1018·1	− 0·4	71	37	61·3	43·4	52·3	− 0·4	44·5	70	3·7	3·17	− 1·67	5	6·9	68
Melbourne	1019·0	− 0·1	63	29	53·8	41·0	47·4	− 1·2	42·8	80	6·3	1·61	− 0·22	15	4·2	42
Adelaide	1021·3	+ 0·9	67	35	57·6	43·2	50·4	− 1·3	45·0	72	5·9	2·34	− 0·31	14	4·6	46
Perth, W. Australia	1021·8	+ 2·8	67	40	61·2	46·6	53·9	− 1·3	49·2	78	6·1	5·29	− 1·16	20	5·2	51
Coolgardie	1022·7	+ 2·8	67	30	60·4	38·8	49·6	− 1·6	44·2	70	3·9	0·40	− 0·51	7	..	..
Brisbane	1019·2	+ 0·7	76	40	68·3	45·2	56·7	− 1·8	48·9	66	2·8	0·53	− 1·81	3	8·6	82
Hobart, Tasmania	1013·8	0·0	56	29	50·9	38·7	44·8	− 0·6	39·3	76	6·9	1·66	− 0·48	22	4·1	44
Wellington, N.Z.	1009·7	− 4·2	57	35	50·6	41·7	46·1	− 1·6	44·0	86	7·3	6·91	+ 1·28	25	3·2	34
Suva, Fiji	1013·4	− 0·8	88	62	80·0	69·4	74·7	+ 1·1	70·3	79	6·2	6·91	+ 2·31	16	4·4	39
Apia, Samoa	1011·6	− 0·4	86	69	83·8	72·9	78·4	+ 1·2	75·1	73	4·1	2·95	+ 0·31	10	6·9	61
Kingston, Jamaica	1014·9	+ 0·2	93	72	89·9	73·8	81·9	+ 0·2	71·6	78	3·9	0·65	− 0·97	3	9·1	69
Grenada, W.I.	1010·4	− 2·8	89	72	86·9	73·6	80·3	+ 1·3	74·5	78	4·0	5·95	− 3·84	23	..	..
Toronto	1015·7	+ 1·6	91	46	79·8	57·6	68·7	+ 0·5	60·6	68	3·6	4·43	+ 1·39	10	10·0	66
Winnipeg	1012·6	− 0·1	96	43	80·1	56·1	68·1	+ 1·9	57·5	83	2·9	1·10	− 2·06	8	10·5	66
St. John, N.B.	1015·1	+ 1·4	79	45	69·4	52·6	61·0	+ 0·6	56·8	77	5·6	1·98	− 1·65	12	8·3	54
Victoria, B.C.	1018·2	+ 1·5	84	48	69·4	52·0	60·7	+ 0·4	54·7	72	4·4	0·25	− 0·11	4	11·2	71

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

St. John, N.B.	1015·1	+ 1·4	79	45	69·4	52·6	61·0	+ 0·6	56·8	77	5·6	1·98	— 1·65	12	8·3	54
Victoria, B.C.	1018·2	+ 1·5	84	48	69·4	52·0	60·7	+ 0·4	54·7	72	4·4	0·25	— 0·11	4	11·2	71

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